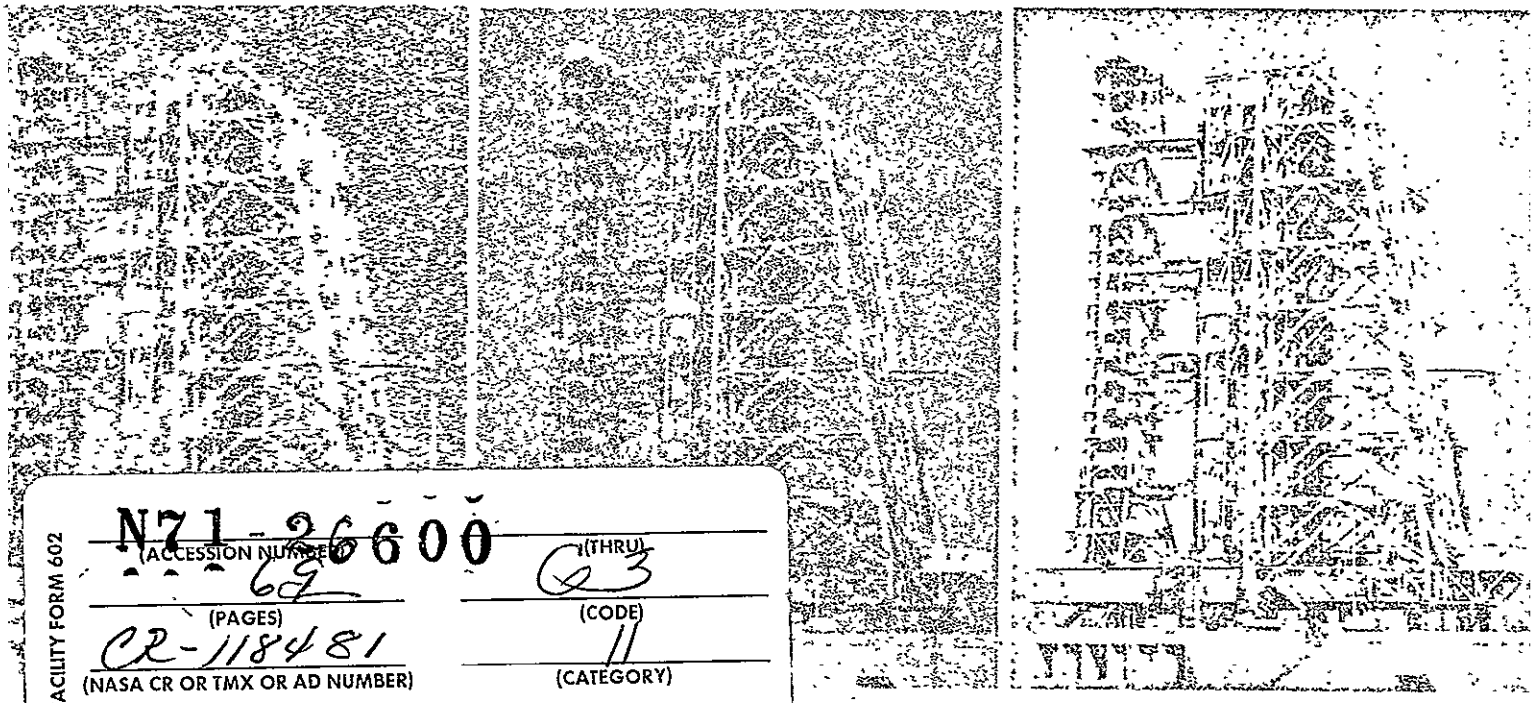

FINAL REPORT ON DEVELOPMENT OF BONDING AND GROUNDING CRITERIA FOR JOHN F. KENNEDY SPACE CENTER

VOLUME III: PREVENTIVE MAINTENANCE INSTRUCTIONS FOR BONDING AND GROUNDING

PHILCO
WDL DIVISION
Philco-Ford Corporation
3939 Fabian Way
Palo Alto, California 94303

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Prepared for
NATIONAL AERONAUTICAL AND SPACE AGENCY (NASA)
JOHN F. KENNEDY SPACE CENTER
KENNEDY SPACE CENTER, FLORIDA 32899

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16. Abstract

// Volume III of this report contains a set of Preventive Maintenance Instructions. A major part of the bonding and grounding anomalies found during the on-site evaluation would not have existed had a systematic program of preventive maintenance been in effect. //This volume contains such a program for all of Launch Complex 39 and the Manned Spacecraft Operation Building. Provision for reporting discrepancies and their follow-up, is also included in this volume.

17. Key Words	18. Distribution Statement		
Bonding, Grounding, EMI, EMC, Nonlinear Junction Reradiation, LC-39, Hazards (Shock, Lightning, Explosion, EMI)	UNCLASSIFIED-UNLIMITED		
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PREFACE

This report describes the studies, analyses, and measurements performed under Contract NAS10-6879 for the development of bonding and grounding criteria for the John F. Kennedy Space Center, Florida.

The report is organized into three volumes, the contents of which are shown in the following table. This table includes the title of each task, the Contract Implementation Plan (CIP) Task Number, the Proposal Task Number, and a short synopsis of each reported task.

VOLUME I - BONDING AND GROUNDING CRITERIA

Section	CIP Task	Title	Proposal Task	Synopsis
1 2 3 4 5 6 Appendix A	 F H 	Introduction Reference Documents Requirements Quality Assurance Preparation for Delivery Notes Rationale for Bonding and Grounding Criteria	11 Modify & Update Existing Standards 12 Update Criteria 14 Prepare Final Report Draft	This volume includes the criteria and standards which are the subject of the contract, using existing standards as a point of departure.

VOLUME II - EVOLUTION OF BONDING AND GROUNDING CRITERIA AND ON-SITE EVALUATION OF BONDING AND GROUNDING

Section	CIP Task	Title	Proposal Task	Synopsis
1		Introduction		
2	A	Review Bonding and Grounding Standards	1A Review of KSC Bibliography 1D Review of Standards other than KSC 2 Reconcile KSC & Other Standards	Current literature was reviewed to determine methods of bonding and grounding employed at KSC and elsewhere.
3	B	Evaluate On-site Bonding and Grounding	1B Study of KSC Environment 1C Define Problem Areas 3 Prepare on-site evaluation procedures 4 Perform on-site evaluation	The bonding and grounding for LC-34, LC-37, and LC-39 were investigated for current condition and implementation. Ground resistance and resistivity measurements were made at selected points. Noise measurements in the time and frequency domains were made during dynamic tests on Apollo 13.
4	C	Define Hazard Environment	1C1 Define Lightning Hazard 1C2 Define Explosion Hazard 1C3 Define EMI Problems & Hazards 1C4 Define Shock Hazards 5 Define Total Hazard Environment	

VOLUME II - EVOLUTION OF BONDING AND GROUNDING CRITERIA AND ON-SITE EVALUATION OF BONDING AND GROUNDING (Continued)

Section	CIP Task	Title	Proposal Task	Synopsis
5	D	Define Areas Requiring Correction	6 Identify on-site deviations & hazards 7 Define anomalies 8 Refine hazard environment	This section reflects areas requiring correction in the relevant KSC specifications and standards as well as on-site anomalies found during the evaluation.
6	E	Present Midterm Report	9 Midterm Report 10 Consolidate comments from Midterm into Baseline	This report was presented at KSC on 20 March 1970. Thirty copies of the presentation material were transmitted to KSC on 6 April 1970, Cite No. 214-NCC-70-0649. None of this material is contained herein, as such.
7	F	Review and Update Criteria and Standards	11 Modify and Update Existing Standards 12 Modify Criteria	Specific paragraph changes required in KSC-STD-E0012 are defined.
8	All	Summary and Conclusions	All	A summary of the work performed on this program is presented. Emphasis is given to the findings of the on-site effort.
9	All	Recommendations	All	Recommendations for corrective action required to correct the anomalies found during the study effort are contained in this section.
Appendix A		Preliminary Model of Grounding System		This preliminary model is a mathematical model developed with emphasis on performance at high frequencies.
Appendix B		Program for Ground Cable Performance Calculation		This appendix includes a program written in Fortran IV for the calculation of ground cable in conduit. Sample runs are given for standard power cable and welding cable.

VOLUME II - EVOLUTION OF BONDING AND GROUNDING CRITERIA AND ON-SITE EVALUATION OF BONDING AND GROUNDING (Continued)

Section	CIP Task	Title	Proposal Task	Synopsis
Appendix C		Electromagnetic Compatibility Guidelines		A number of guidelines including equations and nomographs for EMC design are included in this appendix for reference.

VOLUME III - BONDING AND GROUNDING PREVENTIVE MAINTENANCE INSTRUCTIONS

Section	CIP Task	Title	Proposal Task	Synopsis
1	G	Introduction Objectives Recommendations	13 Prepare bonding and grounding PMI's	This volume contains a set of routines for preventive maintenance on bonding and grounding details to offset what appears to be the most serious problem at KSC in the area of bonding and grounding.

During the work on this project, Philco-Ford Western Development Laboratories has drawn upon its experience in the area of bonding, grounding, and EMI in the Air Force Satellite Control Facility and other classified ground stations as well as its experience with AGE in the checkout of space vehicles. This experience was invaluable in rapidly identifying specific problem areas at the John F. Kennedy Space Center.

ABBREVIATIONS

Wherever used in this document, the following abbreviations are defined as follows:

A/C	Air Conditioning
ACE	Acceptance Checkout Equipment
AF	Audio Frequency
AFSCF	Air Force Satellite Control Facility
AFSTC	Air Force Satellite Test Center (Sunnyvale, California)
AGCS	Automatic Ground Control Station
ASG	Aerospace Ground
AWG	American Wire Gauge
CDDT	Countdown Demonstration Test
CIF	Central Instrumentation Facility
CKAFS	Cape Kennedy Air Force Station
CURFCOE	Spacecraft Communication and Television Control and Distribution Center in the Manned Spacecraft Operations Building
CW	Continuous Wave
ECS	Environmental Control System
EED	Electroexplosive Device
EGP	Earth Ground Point
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
FRT	Firing Readiness Test
GSE	Ground Support Equipment
IR	Current Reference
IU	Instrument Unit
KSC	Kennedy Space Center
LC-34	Launch Complex 34
LC-37	Launch Complex 37
LCC	Launch Control Center
LEM	Lunar Excursion Module
LH_2	Liquid Hydrogen
LOX	Liquid Oxygen
LUT	Launcher/Umbilical Tower

MCM	Thousand Circular Mils
ML	Mobile Launcher
MMH	Monomethylhydrazine
MSOB	Manned Spacecraft Operations Building
MSS	Mobile Service Structure
NASA	National Aeronautical and Space Agency
NEC	National Electric Code
N_2OH	Nitrous Tetroxide
OIS	Operational Intercommunication System
PMI	Preventive Maintenance Instruction
PTCR	Pad Terminal Connection Room
RF	Radio Frequency
RFI	Radio Frequency Interference
RP-1	Rocket Propellant
SA5	Saturn/Apollo V
S/C	Spacecraft
SCR	Silicon Controlled Rectifier
SHF	Super-high Frequency
S-I-C	Saturn/Apollo V First Stage
S-II	Saturn/Apollo V Second Stage
S-IV-B	Saturn/Apollo V Third Stage
TD's	Technical Distributors
TWT	Traveling Wave Tube
USB	Universal S-Band
VAB	Vehicle Assembly Building
VR	Voltage Reference

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SECTION 1

INTRODUCTION

The Preventive Maintenance Instructions (PMI's) in this volume are a part of the report on the Grounding and Bonding Investigation for the John F. Kennedy Space Center under Contract NAS10-6879.

1.1 SCOPE

The PMI routines presented here were evolved during the course of the on-site investigation and subsequent analysis of test data, and apply to the areas which were assessed during the investigation.

1.2 DEFINITION

A Preventive Maintenance Instruction (PMI) is a routine for the periodic inspection of a specific equipment, subsystem, or system. It includes the following information:

a. Equipment, subsystem, or system to be inspected
b. Identifying number
c. Period of performance
d. Tools, equipment, and materials required
e. Detailed inspecting/testing procedure
f. Reporting procedure
g. Historical log of PMI actions

SECTION 2

PMI ROUTINES

2.1 GENERAL

The objective of a comprehensive PMI schedule is to establish a pattern of response to a given inspection routine. If the routine is performed on a regularly scheduled basis, the data obtained will serve to anticipate pending maintenance problems that are not ordinarily apparent during routine operating schedules.

2.2 PMI ROUTINE

Several routines that can be used to establish a scheduled inspection for the areas investigated during the on-site study are included in this volume. Table 2-1 lists the routines by purpose, identification number, and area of inspection. Also included is a sample of a Completion Report Form that must be a part of each PMI.

TABLE 2-1

PMI ROUTINES INCLUDED IN VOLUME III

Purpose	Identifying Number	Facility Inspected	Page
Inspection of Lightning Protection System	LPS-1 LPS-2 LPS-3 LPS-4	VAB MSOB Pads A and B LUT's 1, 2, 3	2-2 2-4 2-6 2-8
Grounding System Noise Signature	ENS-1 ENS-2 ENS-3 ENS-4	VAB LCC MSOB LUT 1, 2, 3	2-10 2-15 2-20 2-25
Earth Ground Point Resistance Measurement	EGP-1 EGP-2 EGP-3 EGP-4	VAB LCC MSOB Pads A and B	2-30 2-35 2-38 2-41
Bonding	BPR-1	Applicable to all areas	2-44

PREVENTIVE MAINTENANCE INSTRUCTION

VEHICLE ASSEMBLY BUILDING LC-39

LIGHTNING PROTECTION SYSTEM

ROUTINE LPS-1

1.0 GENERAL INFORMATION

a. Purpose of Routine: Inspection of lightning protection system

b. Equipment:

(1) Lightning air terminals and downleads on roof of VAB

(2) Lightning arrestors

c. Period of performance: Semiannual

d. The time required for the performance of this routine is approximately three manhours.

2.0 TECHNICAL DATA REFERENCES

a. KSC-STD-E-0013, Lightning Protection Standard

b. KSC-STD-E-0012, Bonding and Grounding Standard

c. National Electrical Code, 1968

d. Facility Engineering Drawings of Lightning Protection System for the VAB

3.0 TEST EQUIPMENT REQUIRED

a. Camera, Polaroid 110 or equivalent, with flash gun

4.0 MATERIALS REQUIRED

a. Film for camera, 16 exposures

b. Flash bulbs for camera, 16 exposures

5.0 PROCEDURE

a. Inspect for:

(1) Damaged lightning air terminals and downleads

(2) Compression type connectors must be tight. Refer to Paragraph 3.4.6 of KSC-STD-E-0013, 6 June 1969.

(3) Air terminal and downlead dimensions. These must be in accordance with Paragraph 3.4 of KSC-STD-E-0013, 6 June 1969.

(4) Evidence of corrosion that may limit the capability of the air terminal function

b. Verify that:

(1) The air terminal is connected to a ground path.

(2) Work areas or equipment are protected by lightning air terminals. Refer to Paragraph 3.3.1 of KSC-STD-E-0013, 9 June 1969.

(3) Installed lightning arrestors comply with Paragraph 3.4.3 of KSC-STD-E-0013.

6.0 REPORT

a. Complete PMI Completion Report.

b. The results of the measurements, including photographs, will be entered in a chronological record in the cognizant engineering office. The entry to the record will include:

- Name of test
- Date of test
- Results of measurement
- Photographs (when applicable)
- Inspector's general comments
- Copy of report to cognizant engineer

c. The inspector will submit to the cognizant engineer a report of the PMI action. The report will include:

- A copy of the Completion Report
- Results of measurement
- Discrepancies
- Inspector's general comments

PREVENTIVE MAINTENANCE INSTRUCTION

MANNED SPACECRAFT OPERATIONS BUILDING

LIGHTNING PROTECTION SYSTEM

ROUTINE LPS-2

1.0 GENERAL INFORMATION

a. Purpose of Routine: Inspection of lightning protection system

b. Equipment:

(1) Lightning air terminals and downleads on the roof of the MSOB

(2) Lightning arrestors

c. Period of performance: Semiannual

d. The time required for the performance of this routine is approximately three manhours.

2.0 TECHNICAL DATA REFERENCES

a. KSC-STD-E-0013, Lightning Protection Standard

b. KSC-STD-E-0012, Bonding and Grounding Standard

c. National Electrical Code, 1968

d. Facility Engineering Drawing of Lightning Protection System for the MSOB

3.0 TEST EQUIPMENT REQUIRED

a. Camera, Polaroid 110 or equivalent, with flash gun

4.0 MATERIALS REQUIRED

a. Film for camera, 16 exposures

b. Flash bulbs for camera, 16 exposures

5.0 PROCEDURE

a. Inspect for:

(1) Damaged lightning air terminals and downleads

(2) Compression type connectors must be tight. Refer to Paragraph 3.4.6 of KSC-STD-E-0013, 6 June 1969.

(3) Air terminal and downlead dimensions. These must be in accordance with Paragraphs 3.4.5 and 3.4.2 of KSC-STD-E-0013, 6 June 1969.

(4) Evidence of corrosion that may limit the capability of the air terminal function

b. Verify that:

(1) The air terminal is connected to a ground path.

(2) Work areas or equipment are protected by lightning air terminals. Refer to Paragraph 3.3.1 of KSC-STD-E-0013, 6 June 1969.

(3) Installed lightning arrestors comply with Paragraph 3.4.3 of KSC-STD-E-0013.

6.0 REPORT

a. Complete a PMI Completion Report.

b. The results of the measurements, including photographs, will be entered in a chronological record in the cognizant engineering office. The entry to the record will include:

- Name of test
- Date of test
- Results of measurement
- Photographs (when applicable)
- Inspector's general comments
- Copy of report to cognizant engineer

c. The inspector will submit to the cognizant engineer a report of the PMI action. The report will include:

- A copy of the Completion Report
- Results of measurements
- Discrepancies
- Inspector's general comments

PREVENTIVE MAINTENANCE INSTRUCTION

LC-39 PAD A AND PAD B

LIGHTNING PROTECTION SYSTEM

ROUTINE LPS-3

1.0 GENERAL INFORMATION

a. Purpose of Routine: Inspection of lightning protection system

b. Equipment:

(1) Lightning air terminals and downleads

(2) Lightning arrestors

c. Period of performance: Semiannual

d. The time required for the performance of this routine is approximately three manhours per pad.

2.0 TECHNICAL DATA REFERENCES

a. KSC-STD-E-0013, Lightning Protection Standard

b. KSC-STD-E-0013, Bonding and Grounding Standard

c. National Electrical Code, 1968

d. Facility Engineering Drawing of Lightning Protection System for LC-39 Launch Pads

3.0 TEST EQUIPMENT REQUIRED

a. Camera, Polaroid 110 or equivalent, and flash gun.

4.0 MATERIALS REQUIRED

a. Film for camera, 16 exposures

b. Flash bulbs for camera, 16 exposures

5.0 PROCEDURE

a. Inspect for:

(1) Damaged lightning air terminals and downleads

(2) Compression type connectors must be tight. Refer to Paragraph 3.4.6 of KSC-STD-E-0013, 6 June 1969.

(3) Air terminal and downlead dimensions. These must be in accordance with Paragraph 3.4 of KSC-STD-E-0013, 6 June 1969.

(4) Evidence of corrosion that may limit the capability of the air terminal function

b. Verify that:

(1) The air terminal is connected to a ground path.

(2) Work areas or equipment are protected by lightning air terminals. Refer to Paragraph 3.3.1 of KSC-STD-E-0013, 9 June 1969.

(3) Installed lightning arrestors comply with Paragraph 3.4.3 of KSC-STD-E-0013.

6.0 REPORT

a. Complete a PMI Completion Report.

b. The results of the measurements, including photographs, will be entered in a chronological record in the cognizant engineering office. The entry to the record will include:

- Name of test
- Date of test
- Results of measurement
- Photographs (when applicable)
- Inspector's general comments
- Copy of report to cognizant engineer

c. The inspector will submit to the cognizant engineer a report of the PMI action. This report will include:

- A copy of the Completion Report
- Results of measurements
- Discrepancies
- Inspector's general comments

PREVENTIVE MAINTENANCE INSTRUCTION

LAUNCHER/UMBILICAL TOWERS

LUT'S 1, 2, AND 3

LIGHTNING PROTECTION SYSTEM

ROUTINE LPS-4

1.0 GENERAL INFORMATION

a. Purpose of Routine: Inspection of lightning protection system

b. Equipment:

(1) Lightning air terminals and downleads

(2) Lightning arrestors

c. Period of performance: Semiannual

d. The time required for the performance of this routine is approximately three manhours per LUT.

2.0 TECHNICAL DATA REFERENCES

a. KSC-STD-E-0013, Lightning Protection Standard

b. KSC-STD-E-0012, Bonding and Grounding Standard

c. National Electrical Code, 1968

d. Facility Engineering Drawing of Lightning Protection System for LC-39 LUT's 1, 2, and 3

3.0 TEST EQUIPMENT REQUIRED

a. Camera, Polaroid 110 or equivalent, and flash gun

4.0 MATERIALS REQUIRED

a. Film for camera, 16 exposures

b. Flash bulbs for camera, 16 exposures

5.0 PROCEDURE

a. Inspect for:

(1) Damaged lightning air terminals and downleads

(2) Compression type connectors must be tight. Refer to Paragraph 3.4.6 of KSC-STD-E-0013, 6 June 1969.

(3) Air terminals and downlead dimensions must be in accordance with Paragraph 3.4 of KSC-STD-E-0013, 6 June 1969.

(4) Evidence of corrosion that may limit the capability of the air terminal function

b. Verify that:

(1) The air terminal is connected to a ground path.

(2) Work areas or equipment are protected by lightning air terminals. Refer to Paragraph 3.3.1 of KSC-STD-E-0013, 9 June 1969

(3) Installed lightning arrestors comply with Paragraph 3.4.3 of KSC-STD-E-0013.

6.0 REPORT

a. Complete a PMI Completion Report.

b. The results of the measurement, including photographs, will be entered in a chronological record in the cognizant engineering office. The entry to the record will include:

- Name of test
- Date of test
- Results of measurement
- Photographs (when applicable)
- Inspector's general comments
- Copy of report to cognizant engineer

c. The inspector will submit to the cognizant engineer a report of the PMI action. This report will include:

- A copy of the Completion Report
- Results of measurement
- Discrepancies
- Inspector's general comments

PREVENTIVE MAINTENANCE INSTRUCTION

VEHICLE ASSEMBLY BUILDING LC-39

GROUND SYSTEM NOISE SIGNATURE

ROUTINE ENS-1

1.0 GENERAL INFORMATION

a. Purpose of Routine: To observe the electrical noise signature on the grounding systems in Room 26E7 of the VAB

b. Equipment:

(1) Static Ground Bus

(2) I-Ground Plate

c. Period of performance: Semiannual

d. The time required for the performance of this routine is approximately 16 manhours.

2.0 TECHNICAL DATA REFERENCES

a. Test equipment technical operating manuals

b. WDL-TR3274, Grounding System Guidelines for Remote Tracking Stations, 1 June 1967

c. KSC-STD-E-0012, Bonding and Grounding Standard

3.0 TEST EQUIPMENT REQUIRED

a. Tektronix 547 Oscilloscope

b. Tektronix Type L Plug-In

c. Tektronix 1L-5 Plug-In

d. Tektronix 1L-10 Plug-In

e. Tektronix C-27 Scope Camera

f. Parallel Ground Adapter AC Plug

(NOTE: Equivalent equipment may be used for Items 3a through 3e.)

4.0 MATERIALS REQUIRED

a. Film for oscilloscope camera, quantity as required

b. RG-213 coaxial cable, or equivalent, quantity as required

c. RG-59 coaxial cable, or equivalent, quantity as required

5.0 PROCEDURE

a. Allow 30 minutes for equipment warmup.

b. Record test equipment control settings and connections.

c. In Room 26E7, observe and record the noise signatures in both the time and frequency domains for:

(1) Static Ground Bus at point where rack 12 is connected

(2) Instrumentation Ground Plate

A simplified sketch of the test equipment configuration and approximate location of the various grounds is shown in Figure 1.

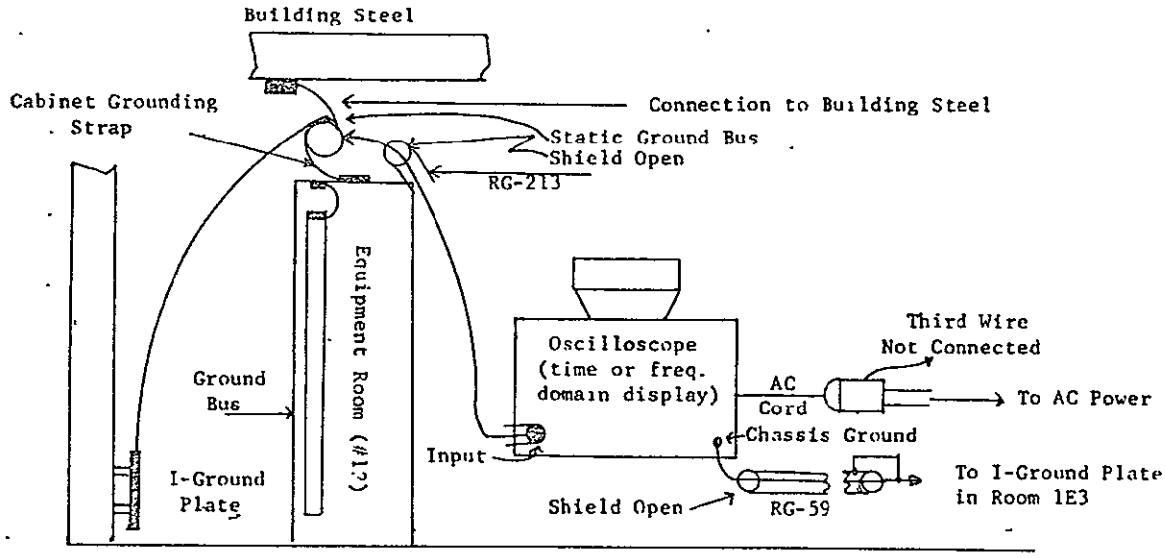


Figure 1 Typical Equipment Configuration for Noise Measurement, Room 26E7, Vehicle Assembly Building

d. The frequency domain signature for the spectrum of 10 Hz to 1 MHz will be photographed for each of the grounding systems listed in Paragraph 5c above. The spectrum analyzer controls will be set so that the spectrum can be recorded on a photograph. Figure 2 is an illustration of the type of photograph desired.

Instrumentation:

547 Oscilloscope
1L-5 Plug-In
Center Frequency, 500 kHz
Dispersion, 100 kHz/cm
Horizontal Sweep, 50 ms/cm
Vertical Gain, 1 mV/cm
Single Trace Sweep

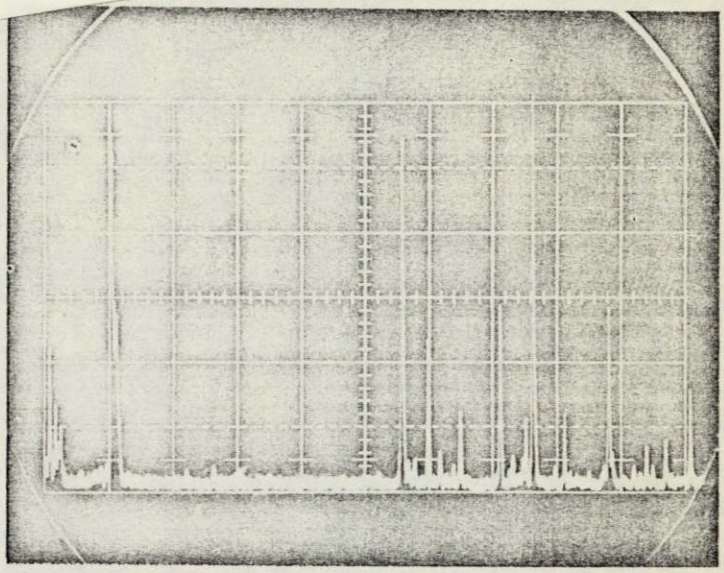


Figure 2 Sample Photograph of 10-Hz to 1-MHz Frequency Spectrum

e. Prior to the start of recording, the ambient noise level in the test equipment and test leads should be established. This can be accomplished by:

- Connecting equipment as shown in Figure 1
- Installing 1L-5 plug-in into oscilloscope
- Allowing 30-minute warmup
- Opening input to RG-213
- Setting equipment for 1-MHz spectrum and maximum gain
- Logging observations and photographing spectrum

f. Signature for 10-Hz to 1-MHz frequency domain:

- Upon completion of step e, connect the RG-213 test lead to the static ground bus.
- Adjust oscilloscope controls to obtain a spectrum display that is within the limits of the display graticule.
- Log control settings and observations.
- Photograph spectrum using single-sweep trace.
- Repeat above procedure for the I-Ground.

g. Signatures for 1-MHz to 30-MHz frequency domain:

- Upon completion of step f, install the 1L-10 plug-in into the oscilloscope and allow 30-minute warmup.
- Connect RG-213 test lead to static ground bus and set spectrum analyzer sweep controls for broadband sweep.
- Frequencies observed in the 1-MHz to 30-MHz range that are 12 dl above threshold should be logged. The inspector should use his judgment on the necessity of photographing his observations. This should be done for each of the ground systems.

h. Signature for time domain:

- Upon completion of step g, install the Type L plug-in into the oscilloscope and allow 30-minute warmup.
- Set control for maximum gain and oscilloscope sweep at 2 ms/cm.
- Allow RG-213 test lead to remain open and log and photograph ambient noise.
- Connect test lead to static ground, set the Type L gain control to obtain a display that does not overrun the upper and lower margin of the display graticule.
- Log settings, observations, and photograph display.

The inspector's comments regarding ground system noise phenomena which may not be readily photographed will be entered in his log of events. This is especially true in the case of transient noise voltage spikes, which are very difficult to photograph.

6.0 REPORT

a. Complete a PMI Completion Report.

b. The results of the measurements and the photographs will be entered in a chronological record in the cognizant engineering office. The entry to the record will include:

- Date of test
- Equipment used
- Results of measurements
- Photographs
- Inspector's general comments
- Copy of report to cognizant engineer

c. The inspector will submit to the cognizant engineer a report of the PMI action. The report will include:

- A copy of the Completion Report
- Results of measurements
- Discrepancies
- Inspector's general comments

7.0 OBJECTIVE

To establish a chronological record of the noise voltages that exist at a known point on the VAB grounding systems. When a PMI measurement shows a significant departure from the record, an investigation should be initiated to determine the cause.

The noise voltage measurements in Volume II, Section 3 of WDL-TR4201 will serve as an initial reference for the first entries into the record.

PREVENTIVE MAINTENANCE INSTRUCTION

LAUNCH CONTROL CENTER, LC-39

GROUND SYSTEM NOISE SIGNATURES

ROUTINE ENS-2

1.0 GENERAL INFORMATION

a. Purpose of Routine: To observe the electrical noise signature on the grounding systems in Firing Room 1 of the LCC

b. Equipment:

(1) Static Ground Bus

(2) Signal Ground Bus

(3) I-Ground Plate

(4) E-Ground Grid

c. Period of performance: Semiannua

d. The time required for the performance of this routine is approximately 16 manhours.

2.0 TECHNICAL DATA REFERENCES

a. Test equipment technical operating manuals

b. WDL-TR3274, Grounding System Guidelines for Remote Tracking Stations, 1 June 1967

c. KSC-STD-E-0012, Bonding and Grounding Standard

3.0 TEST EQUIPMENT REQUIRED

a. Tektronix 547 Oscilloscope

b. Tektronix Type L Plug-In

c. Tektronix 1L-5 Plug-In

d. Tektronix 1L-10 Plug-In

e. Tektronix C-27 Scope Camera

f. Parallel Ground Adapter AC Plug

(NOTE: Equivalent equipment may be used for Items 3a through 3e.)

4.0 MATERIALS REQUIRED

a. Film for oscilloscope camera quantity as required

b. RG-213 coaxial cable, or equivalent, quantity as required

c. RG-59 coaxial cable, or equivalent, quantity as required

5.0 PROCEDURE

a. Allow 30 minutes for equipment warmup.

b. Record test equipment control settings and connections.

c. In Firing Room 1, at a location near the entrance to Room 3P13, observe and record the noise signatures in both the time and frequency domain for:

(1) Signal Ground Bus

(2) Static Ground Bus

(3) Instrumentation Ground Plate

(4) The E-Ground Grid.

A simplified sketch of the test equipment configuration and approximate location of the various grounds is shown in Figure 3.

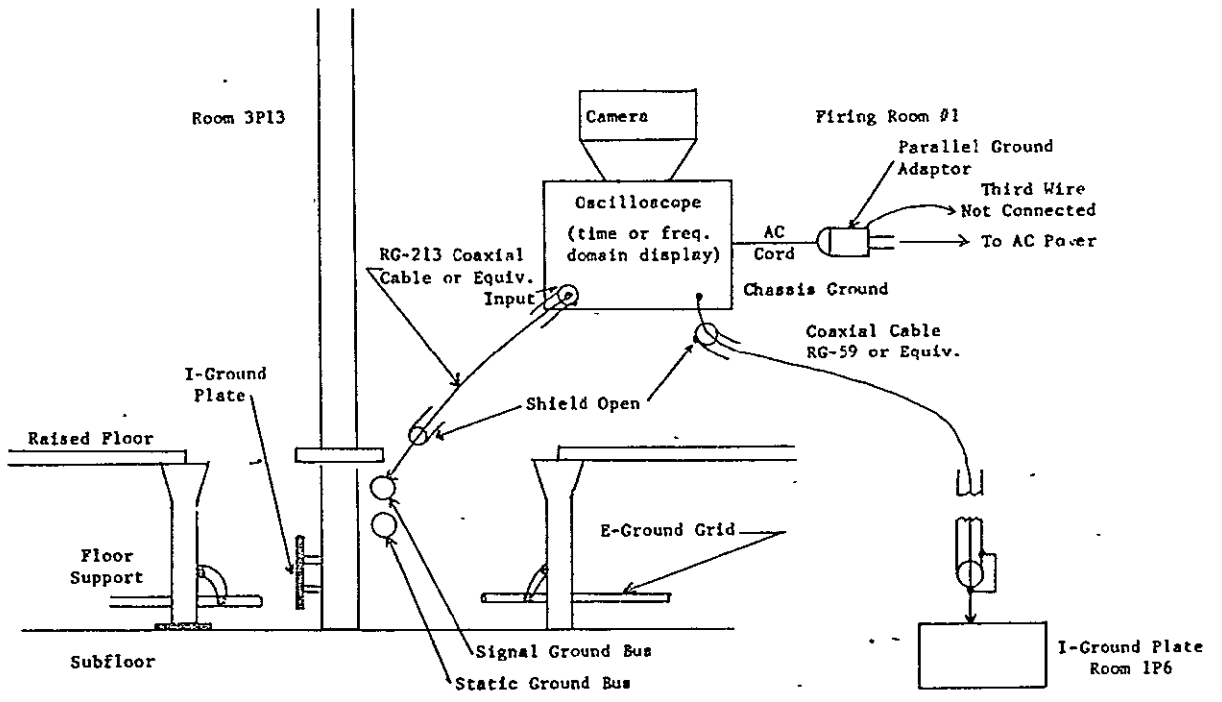


Figure 3 Typical Test Equipment Configuration for Noise Signature Measurements Launch Control Center Firing Room 1

d. The frequency domain signature for the spectrum of 10-Hz to 1-MHz will be photographed for each of the grounding systems listed in Paragraph 5c. The spectrum analyzer controls will be set so that the spectrum can be recorded on a single photograph. Figure 4 is an illustration of the type of photograph desired.

Instrumentation:

547 Tektronix Oscilloscope
1L-5 Tektronix Plug-in
Center Frequency, 500 kHz
Dispersion, 100 kHz/cm
Horizontal Sweep, 50 ms/cm
Vertical Gain, 0.20 mV/cm
Single Trace Sweep

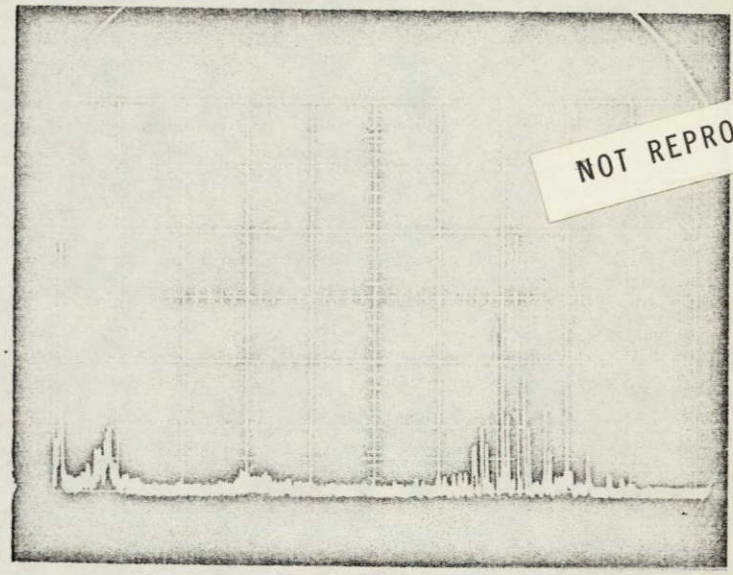


Figure 4 Sample Photograph of 10-Hz to 1-MHz Frequency Spectrum

e. Prior to the start of recording, the ambient noise level in the test equipment and test leads should be established. This can be accomplished by:

- Connecting equipment as shown in Figure 3
- Installing 1L-5 plug-in into oscilloscope
- Allowing a 30-minute warmup
- Connecting the RG-213 test cable to the oscilloscope, leaving the other end disconnected
- Setting equipment for 1-MHz spectrum and maximum gain
- Logging observations and photographing spectrum

f. Signatures for 10-Hz to 1-MHz frequency domain:

- Upon completion of step e, connect the RG-213 test lead to the signal ground bus.
- Adjust oscilloscope controls to obtain a spectrum display that is within the limits of the display graticule.

- Log control settings and observations.
- Photograph spectrum using single sweep trace.
- Repeat above procedure for the static Ground, I-Ground and E-Ground.

g. Signatures for 1-MHz to 30-MHz frequency domain:

- Upon completion of step f, install the 1L-10 plug-in into the oscilloscope and allow 30-minute warm-up.
- Connect RG-213 test lead to signal ground bus and set spectrum analyzer sweep controls for broadband sweep.
- Frequencies observed in the 1-MHz to 30-MHz range that are 12 dB above threshold should be logged. The inspector should use his judgement on the necessity of photographing his observations. This should be done for each of the ground systems.

h. Signature for time domain:

- Upon completion of step g, install the Type L plug-in into the oscilloscope and allow 30-minute warmup.
- Set control for maximum gain and oscilloscope sweep at 2 ms/cm.
- Allow RG-213 test lead to remain open as in step e; log and photograph ambient noise.
- Connect test lead to signal ground, set the Type L gain control to obtain a display that does not overrun the upper and lower margins of the display graticule.
- Log settings, observations and photograph display.

i. The inspector's comments regarding ground system noise phenomena which may not be readily photographed will be entered in his log of events. This is especially true in the case of transient noise voltage spikes, which are very difficult to photograph.

.0 REPORT

a. Complete a PMI Completion Report.

b. The results of the measurements and the photographs will be entered in a chronological record in the cognizant engineering office. The entry to the record will include:

- Date of test
- Equipment used
- Results of measurements
- Photographs
- Inspector's general comments
- Copy of report to cognizant engineer

c. The inspector will submit to the cognizant engineer a report of the PMI action. The report will include:

- A copy of the Completion Report
- Results of measurement
- Discrepancies
- Inspector's general comments

7.0 OBJECTIVE

To establish a chronological record of the noise voltages that exist at a known point on the various grounding systems. When a PMI measurement shows a significant departure from the record, an investigation should be initiated to determine the cause.

The noise voltage measurements in Section 3, Volume II of this report will serve as an initial reference for the first entries into the record.

PREVENTIVE MAINTENANCE INSTRUCTION
MANNED SPACECRAFT OPERATIONS BUILDING
GROUND SYSTEM NOISE SIGNATURE
ROUTINE ENS-3

1.0 GENERAL INFORMATION

a. Purpose of Routine: To observe the electrical noise signature on the grounding systems in Room 3227 (CURFCOE) of the MSOB

b. Equipment:

(1) Static Ground Bus

(2) Signal Ground Bus

(3) E-Ground Grid

c. Period of Performance: Semiannual

d. The time required for the performance of this routine is approximately 16 manhours.

2.0 TECHNICAL DATA REFERENCES

a. Test equipment technical operating manuals

b. WDL-TR3274, Grounding System Guidelines for Remote Tracking Stations

c. KSC-STD-E-0012, Bonding and Grounding Standard

3.0 TEST EQUIPMENT REQUIRED

a. Tektronix 547 Oscilloscope
b. Tektronix Type L Plug-In
c. Tektronix 1L-5 Plug-In
d. Tektronix 1L-10 Plug-In
e. Tektronix C-27 Scope Camera
f. Parallel Ground Adapter AC Plug

(NOTE: Equivalent equipment may be used for items 3a through 3e.)

4.0 MATERIALS REQUIRED

a. Film for oscilloscope camera, quantities as required

b. RG-213 coaxial cable, or equivalent, quantity as required

c. RG-59 coaxial cable, or equivalent, quantity as required

5.0 PROCEDURE

a. Allow 30 minutes for equipment warmup.

b. Record test equipment control settings and connections.

c. At a location behind Rack 19, observe and record the noise signature in both the time and frequency domains for:

(1) Signal Ground Bus

(2) Static Ground Bus

(3) E-Ground Grid

A simplified sketch of the test equipment configuration and approximate location of the various grounds is shown in Figure 5

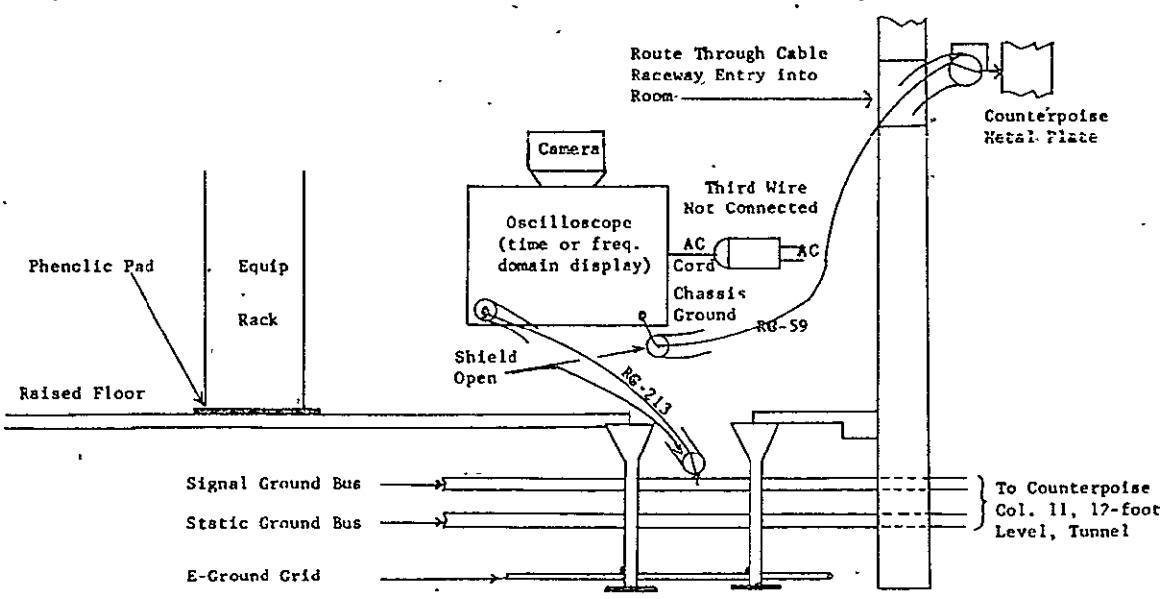


Figure 5 Typical Test Equipment Configuration for Noise Signature Measurements, Room 3227 (CURFCOE), Manned Spacecraft Operations Building

d. The frequency domain signature for the spectrum of 10 Hz to 1 MHz will be photographed for each of the grounding systems listed in Paragraph 5c. The spectrum analyzer controls will be set so that the spectrum can be recorded on a single photograph. Figure 6 is an illustration of the type of photograph desired.

Instrumentation:

547 Tektronix Oscilloscope
IL-5 Tektronix Plug-in
Center Frequency, 500 kHz
Dispersion, 100 kHz/cm
Horizontal Sweep, 50 ms/cm
Vertical Gain, 0.1 mV/cm
Single Track Sweep

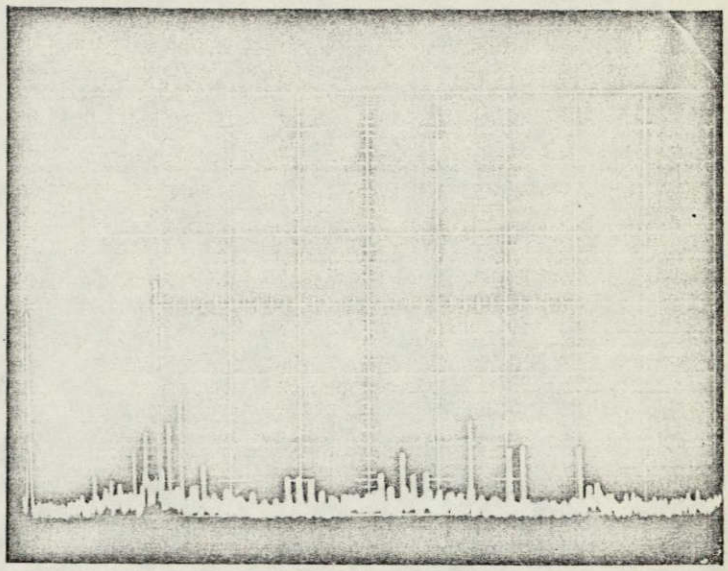


Figure 6 Sample Photograph of 10-Hz to 1-MHz Frequency Spectrum

e. Prior to the start of recording, the ambient noise level in the test equipment and test leads should be established. This can be accomplished by:

- Connecting equipment as shown in Figure 5
- Installing IL-5 plug-in into oscilloscope
- Allowing 30-minute warmup
- Opening input to RG-213
- Setting equipment for 1-MHz spectrum and maximum gain
- Logging observations and photographing spectrum

f. Signatures for 10-Hz to 1-MHz frequency domain:

- Upon completion of step e, connect the RG-213 test lead to the signal ground bus.
- Adjust oscilloscope controls to obtain a spectrum display that is within the limits of the display graticule.
- Log control settings and observations.
- Photograph spectrum using single-sweep trace.
- Repeat above procedure for the Static Ground and E-Ground.

g. Signatures for 1-MHz to 30-MHz frequency domain:

- Upon completion of step f, install the IL-10 plug-in into the oscilloscope and allow 30-minute warmup.
- Connect RG-213 test lead to signal ground bus and set spectrum analyzer sweep controls for broadband sweep.
- Frequencies observed in the 1-MHz to 30-MHz range that are 12 dB above threshold should be logged. The inspector should use his judgement on the necessity of photographing his observations. This should be done for each of the ground systems.

h. Signature for time domain:

- Upon completion of step g, install the Type L plug-in into the oscilloscope and allow 30-minute warmup.
- Set control for maximum gain and oscilloscope sweep at 2 ms/cm.
- Allow RG-213 test lead to remain open; log and photograph ambient noise.
- Connect test lead to signal ground, set the Type L gain control to obtain a display that does not overrun the upper and lower margin of the display graticule.
- Log settings, observations, and photograph display.

i. The inspector's comments regarding ground system noise phenomena which may not be readily photographed will be entered in his log of events. This is especially true in the case of transient noise voltage spikes, which are very difficult to photograph.

6.0 REPORT

a. Complete a PMI Completion Report.

b. The results of the measurements and the photographs will be entered in a chronological record in the cognizant engineering office. The entry to the record will include:

- Date of test
- Equipment used
- Results of measurements
- Photographs
- Inspector's general comments
- Copy of report to cognizant engineer

c. The inspector will submit to the cognizant engineer a report of the PMI action. The report will include:

- A copy of the Completion Report
- Results of measurements
- Discrepancies
- Inspector's general comments

.. OBJECTIVE

To establish a chronological record of the noise voltages that exist at a known point on the various grounding systems. When a PMI measurement shows a significant departure from the record, an investigation should be initiated to determine the cause.

The noise voltage measurements in Volume II, Section 3 of this report will serve as an initial reference for the first entries into the record.

PREVENTIVE MAINTENANCE INSTRUCTION

LAUNCHER UMBILICAL TOWERS 1, 2, AND 3

GROUND SYSTEM NOISE SIGNATURE

ROUTINE ENS-4

1.0 GENERAL INFORMATION

a. Purpose of Routine: To observe the electrical noise signature on the grounding systems in the ACE Room

b. Equipment:

(1) I-Ground Plate

(2) E-Ground Plate

c. Period of Performance: Semiannual

d. The time required for the performance of this routine is approximately 16 manhours.

.0 TECHNICAL DATA REFERENCES

a. Test equipment technical operating manuals

b. WDL-TR3274, Grounding System Guidelines for Remote Tracking Stations, 1 June 1967

c. KSC-STD-E-0012, Bonding and Grounding Standard

.0 TEST EQUIPMENT REQUIRED

a. Tektronix 547 Oscilloscope
b. Tektronix Type L Plug-In
c. Tektronix IL-5 Plug-In
d. Tektronix IL-10 Plug-In
e. Tektronix C-27 Scope Camera
f. Parallel Ground Adapter AC Plug

(NOTE: Equivalent equipment may be used for Items 3a through 3e.)

.0 MATERIALS REQUIRED

a. Film for oscilloscope camera

b. RG-213 coaxial cable, or equivalent, quantity as required

c. RG-59 coaxial cable, or equivalent, quantity as required

5.0 PROCEDURE

a. Allow 30 minutes for equipment warmup.

b. Record test equipment control settings and connections.

c. In the ACE Room, observe and record the noise signatures in both the time and frequency domains for:

(1) Instrumentation Ground Bus

(2) E-Ground Bus

A simplified sketch of the test equipment configuration and approximate location of the various grounds is shown in Figure 7.

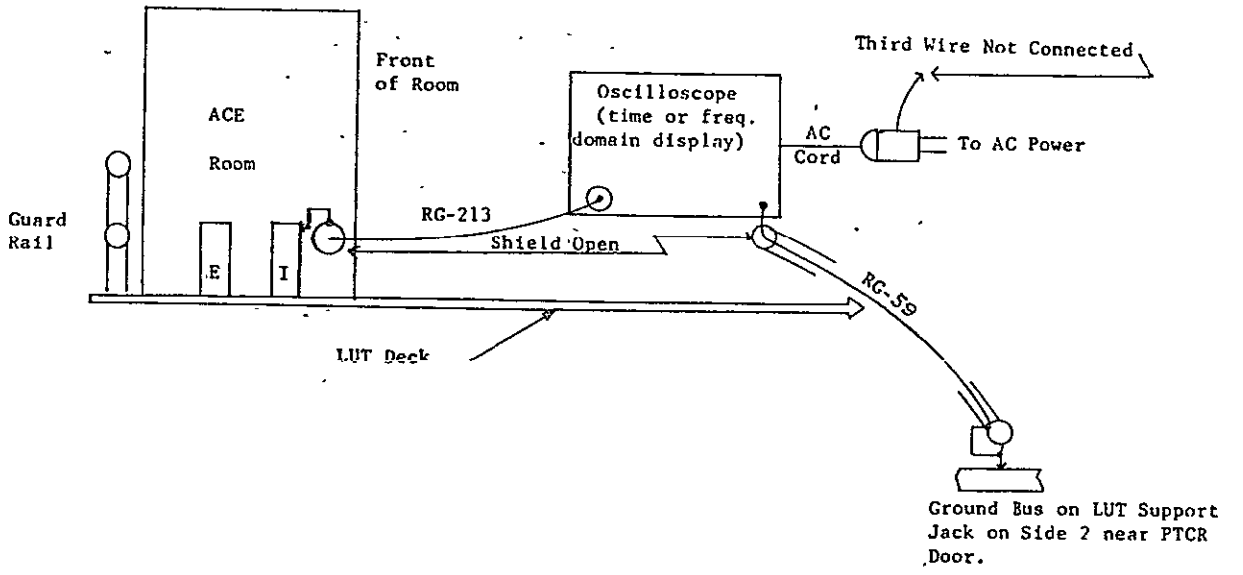


Figure 7 Typical Test Equipment Configuration for Noise Signature Measurements LUT Tower Level Supporting ACE Room

d. The frequency domain signature for the spectrum of 10 Hz to 1 MHz will be photographed for each of the grounding systems listed in Paragraph 5c. The spectrum analyzer controls will be set so that the spectrum can be recorded on a photograph. Figure 8 is an illustration of the type of photograph desired.

e. Prior to the start of recording, the ambient noise level in the test equipment and test leads should be established. This can be accomplished by:

- Connecting equipment as shown in Figure 7
- Installing IL-5 plug-in into oscilloscope
- Allowing 30-minute warmup

Instrumentations:

547 Tektronix Oscilloscope
IL-5 Tektronix Plug-in
Center Frequency 500 kHz
Dispersion, 100 kHz/cm
Horizontal Sweep, 50 ms/cm
Vertical Gain, 0.1 mV/cm
Single Trace Sweep

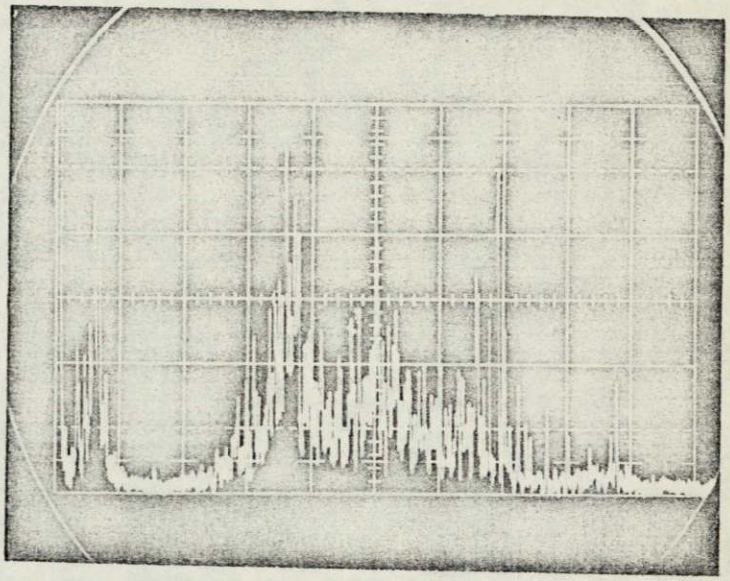


Figure 8 Sample Photograph of 10-Hz to 1-MHz Frequency Spectrum

- Opening input to RG-213
- Setting equipment for 1 MHz spectrum and maximum gain
- Logging observations and photograph spectrum

f. Signature for 10-Hz to 1-MHz frequency domain:

- Upon completion of step e, connect the RG-213 test lead to the I-Ground.
- Adjust oscilloscope controls to obtain a spectrum display that is within the limits of the display graticule.
- Log control settings and observations.
- Photograph spectrum using single sweep trace.
- Repeat above procedure for the E-Ground.

g. Signatures for 1-MHz to 30-MHz frequency domain:

- Upon completion of step f, install the IL-10 plug-in into the oscilloscope and allow 30-minute warmup.
- Connect RG-213 test lead to signal ground bus and set spectrum analyzer sweep controls for broadband sweep.
- Frequencies observed in the 1-MHz to 30-MHz range that are 12 dB above threshold should be logged. The inspector should use his judgement on the necessity of photographing his observations. This should be done for each of the ground systems.

h. Signature for time domain:

- Upon completion of step g, install the Type L plug-in into the oscilloscope and allow 30-minute warmup.
- Set control for maximum gain and oscilloscope sweep at 2 ms/cm.
- Allow RG-213 test lead to remain open; log and photograph ambient noise.
- Connect test lead to signal ground; set the Type L gain control to obtain a display that does not overrun the upper and lower margins of the display graticule.
- Log settings, observations, and photograph display.

i. The inspector's comments regarding ground system noise phenomena which may not be readily photographed will be entered in his log of events. This is especially true in the case of transient noise voltages spikes, which are very difficult to photograph.

6.0 REPORT

a. Complete a PMI Completion Report.

b. The results of the measurements and the photographs will be entered in a chronological record in the cognizant engineering office. The entry to the record will include:

- Date of test
- Equipment used
- Results of measurements
- Photographs
- Inspector's general comments
- Copy of report to cognizant engineer

c. The inspector will submit to the cognizant engineer a report of the PMI action. The report will include:

- A copy of the Completion Report
- Results of measurements
- Discrepancies
- Inspector's general comments

7.0 OBJECTIVE

To establish a chronological record of the noise voltages that exist at a known point on the various grounding systems. When a PMI measurement shows a significant departure from the record, an investigation should be initiated to determine the cause.

The noise voltage measurements in Volume II, Section 3 of this report will serve as an initial reference for the first entries into the record.

PREVENTIVE MAINTENANCE INSTRUCTION

VEHICLE ASSEMBLY BUILDING, LC-39

EARTH GROUND POINT RESISTANCE MEASUREMENT

ROUTINE EGP-1

.0 GENERAL INFORMATION

a. Purpose of Routine: To measure the resistance to earth of the Earth Ground Point for the Instrumentation (I) and Building (E) Grounds

b. Period of Performance: Semiannual

c. The time required for the performance of this routine is approximately 6 manhours.

.0 TECHNICAL DATA REFERENCES

a. KSC-STD-E-0012, Bonding and Grounding Standard

b. National Electric Code, 1968

.0 TEST EQUIPMENT REQUIRED

a. Ground Resistance Test Set, Associated Research Model 293 Vibroground with 7105 Test Kit, or equivalent

b. 100-Foot Measuring Tape, Power Kraft, 28A4098, or equivalent

.0 MATERIALS REQUIRED

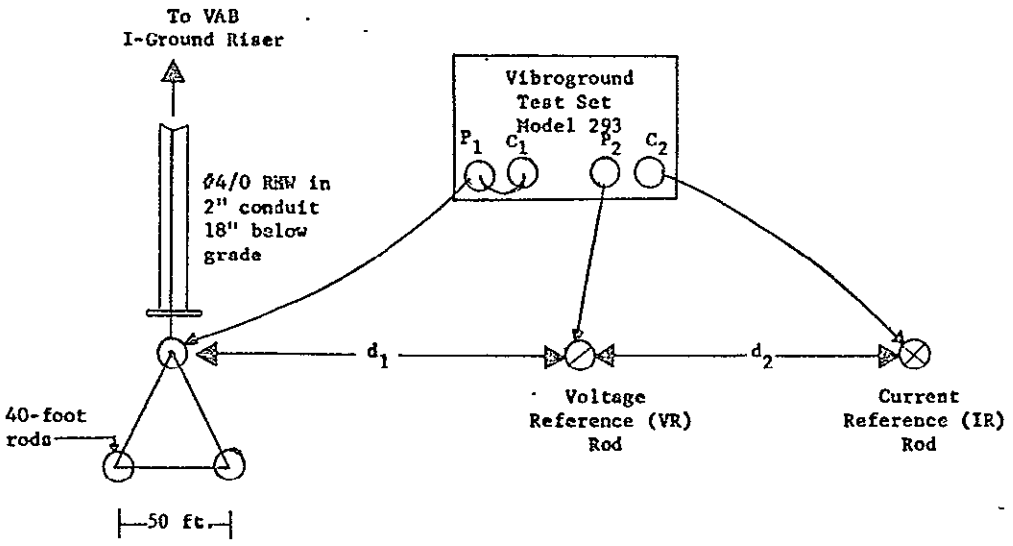
a. Ground stakes (IR and VR rods) and interconnecting test leads if not provided as a part of test set

.0 PROCEDURE

a. Allow 30 minutes for equipment warmup, if required.

b. Note measuring equipment control settings and connections to enable return to initial configuration after routine.

c. If the I-Ground counterpoise is directly accessible, connect the test equipment as is shown in Figure 9 and perform measurement.



NOTES:
1. $d_1 = d_2 \pm 10\%$. 100-foot typical.
2. VR rod should be on-line between IR rod and ground point connection.
3. Reference rods, VR and IR, should be in an area relatively free of underground conductors.

Figure 9 Typical Test Equipment Configuration for Earth Ground Resistance Measurement, VAB I Ground

d. If the counterpoise is not accessible, the most convenient point of access of the I-Ground riser must be used. The test equipment should be connected as is shown in Figure 10; perform measurement.

e. Figure 11 is a sketch of a test equipment configuration that will allow measurement of E-Ground resistance.

f. Procedure for resistance measurement is as follows:

(1) Configure test equipment using Figures 9, 10, or 11 as a guide.

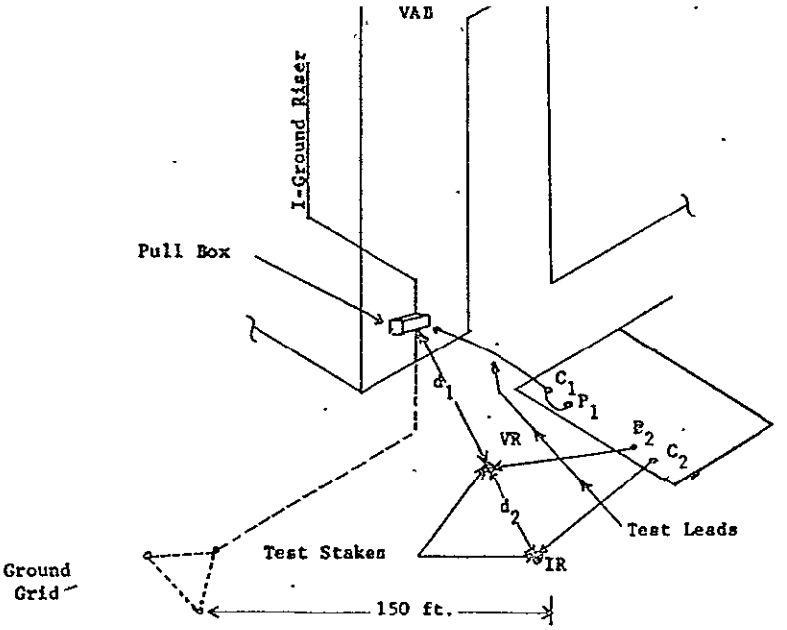
(2) Operate test set to obtain an EGP resistance reading.

(3) Reset controls of test set to zero, then repeat step f(2).

(4) Repeat step f(3).

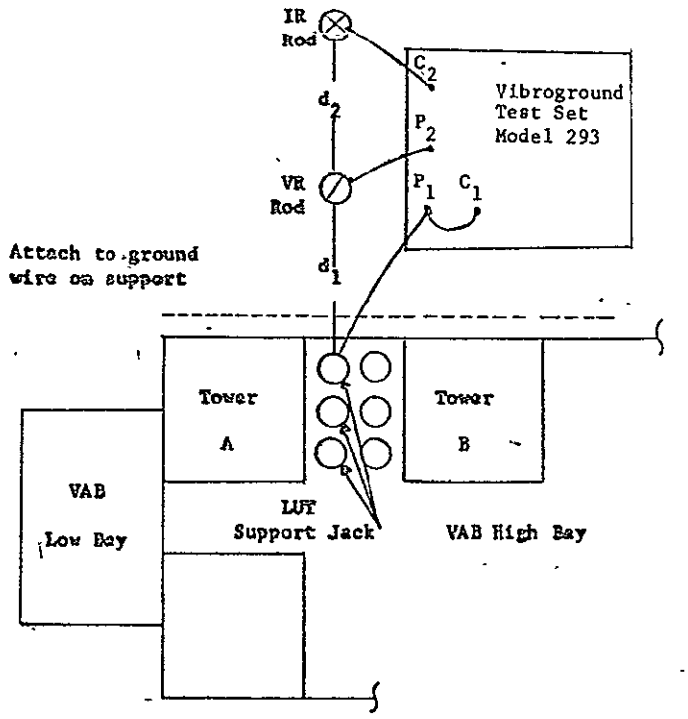
(5) Average of the three readings obtained will be accepted as the EGP resistance. If the readings vary over a wide range, check the test configuration for anomalies.

(6) The resistance value obtained in f(5) should be one ohm or less (KSC-STD-E-0012, Paragraph 3.5.3.4.2.1, 29 December 1969).



NOTE: 1. $d_1 = d_2 \pm 10\%$. 100-foot typical.
2. VR rod should be on-line between IR rod and ground point connection.
3. Reference rods, IR and VR, should be in an area relatively free of underground conductors.

Figure 10 Typical Test Equipment for Earth Ground Resistance Measurement, VAB I Ground



NOTE: 1. $d_1 = d_2 \pm 10\%$. 100-foot typical.
2. VR rod should be on-line between IR rod and ground point connection.
3. Reference rods, VR and IR, should be in an areas relatively free of underground conductors.

Figure 11 Typical Test Equipment Configuration for Earth Ground Measurement, VAB E Ground

g. Perform step f for the E-Ground EGP resistance measurement.

h. Perform step f for the I-Ground counterpoises for Towers A, B, E, D, and F.

i. After completion of step h, one of the I-Ground risers should be disconnected from the counterpoise (e.g., Tower A at the pull box where the conduit penetrates the floor) and a resistance measurement of an isolated ground counterpoise made using the procedure given in step f. A chronological record of this measurement will give an indication of deterioration of the perishable elements in the counterpoise. As the element deteriorates, the resistance will increase. When this resistance exceeds one ohm, corrective action is indicated.

j. Return operating equipment controls and connections to initial configuration.

6.0 REPORT

a. Complete a PMI Completion Report.

b. The results of the measurements will be entered in a chronological record in the cognizant engineering office. The entry to the record will include:

- Date of test
- Equipment used
- Results of measurements
- Inspector's general comments
- Copy of report to cognizant engineer

c. The inspector will submit to the cognizant engineer a report of the PMI action. The report will include:

- A copy of the Completion Report
- Equipment used
- Results of measurement
- Discrepancies
- Inspector's general comments

7.0 OBJECTIVES

a. The objective of this inspection is to establish a chronological record of the earth ground point resistance for the VAB. When a significant departure from the record is noted, an investigation should be initiated to determine the cause.

b. The earth ground point resistance measurements given in Volume II, Section 3 of this report and past experience at KSC will serve as first entries into the record.

PREVENTIVE MAINTENANCE INSTRUCTION

EARTH GROUND POINT RESISTANCE MEASUREMENT

LAUNCH CONTROL CENTER, LC-39

ROUTINE EGP-2

1.0 GENERAL INFORMATION

a. Purpose of Routine: To measure the resistance to earth of the Earth Ground Point for the Instrumentation (I) and Building (E) Grounds

b. Period of Performance: Semiannual

c. The time required for the performance of this routine is approximately 4 manhours.

2.0 TECHNICAL DATA REFERENCES

a. KSC-STD-E-0012, Bonding and Grounding Standard

b. National Electric Code, 1968

3.0 TEST EQUIPMENT REQUIRED

a. Ground Resistance Test Set, Associated Research Model 293 Vibroground with 7105 Test Kit or equivalent

b. 100-Foot Measuring Tape, Power Kraft Z84A4098 or equivalent

4.0 MATERIALS REQUIRED

a. Ground stakes (IR and VR rods) and interconnecting test leads if not provided as a part of test set

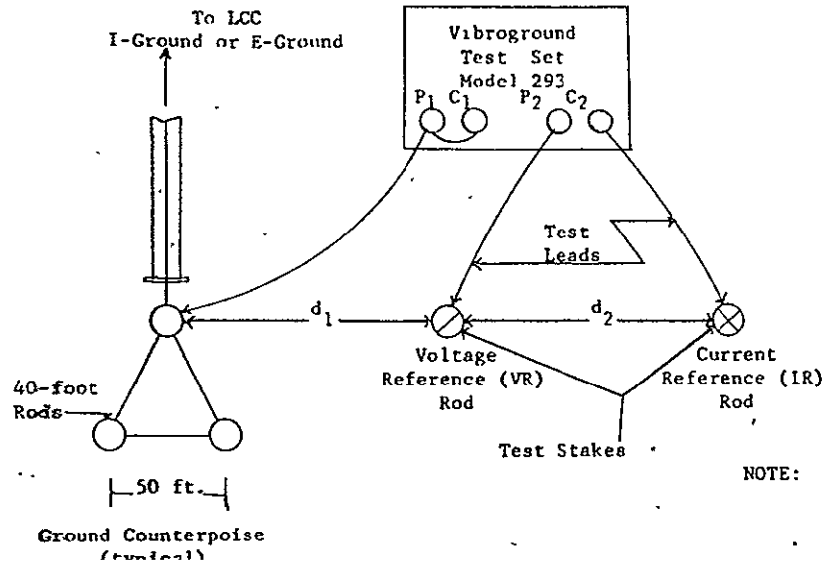
5.0 PROCEDURE

a. Allow 30 minutes for equipment warmup if required.

b. Note measuring equipment control settings and connections to enable return to initial configuration after routine.

c. In the event that an adequate measuring procedure is currently in use, that procedure should be used for this PMI. If a procedure is not currently in practice, the procedure given in Paragraphs 5d through 5f will serve as a guide for this purpose.

d. If the I-Ground counterpoise is directly accessible or accessible through a test point provided for the purpose of measurement, connect the test equipment as is shown in Figure 12 and perform the measurement.



NOTE: 1. $d_1 = d_2 \pm 10\%$. 100-foot typical.

2. VR rod should be on-line between IR rod and ground point connection.

3. Reference rods, VR and IR, should be in an area relatively free of underground conductors.

Figure 12 Typical Test Equipment Configuration for Earth Ground Point Resistance Measurement - LCC

e. If the conditions in step c do not hold, the connection to the EGP must be made at a location convenient for measurement. Location of the IR and VR rods must then be aligned in a straight line with uniform spacing between rods, preferably 100 feet or greater.

f. The procedure for resistance measurement is as follows:

(1) Configure test equipment for measurement.

(2) Operate the test set to obtain an EGP resistance reading.

(3) Reset controls of test set to zero, then repeat step f(2).

(4) Repeat step f(3).

(5) The average of the three readings can be accepted as the EGP resistance. If the readings vary over a wide range, check to test configuration for anomalies.

(6) The resistance value obtained in f(5) should be one ohm or less. Refer to KSC-STD-E-0012, Paragraph 3.5.4.2.1, 29 December 1969.

g. Upon completion of the I-Ground resistance measurement, follow the same general procedure for measurement of the Building (E) Ground resistance.

6.0 REPORT

a. Complete a PMI Completion Report.

b. The results of the measurements will be entered in a chronological record in the cognizant engineering office. The entry to the record will include:

- Date of test
- Equipment used
- Results of measurements
- Inspector's general comments
- Copy of report to cognizant engineer

c. The inspector will submit to the cognizant engineer a report of the PMI action. The report will include:

- A copy of the Completion Report
- Equipment used
- Results of measurements
- Discrepancies
- Inspector's general comments

7.0 OBJECTIVES

The objective of this inspection is to establish a chronological record of the earth ground point resistance for the VAB. When a significant departure from the record is noted, an investigation should be initiated to determine the cause.

The earth ground point resistance measurement given in Volume II, Section 3 of this report and past experience at KSC will serve as first entries into the record.

PREVENTIVE MAINTENANCE INSTRUCTION

MANNED SPACECRAFT OPERATIONS BUILDING

EARTH GROUND POINT RESISTANCE MEASUREMENT

ROUTINE EGP-3

1.0 GENERAL INFORMATION

a. Purpose of Routine: To measure the resistance to earth for the Ground Counterpoise

b. Period of Performance: Semiannual

c. The time required for the performance of this routine is approximately 4 manhours.

2.0 TECHNICAL DATA REFERENCES

a. KSC-STD-E-0012, Bonding and Grounding Standard

b. National Electric Code, 1968

3.0 TEST EQUIPMENT REQUIRED

a. Ground Resistance Test Set, Associated Research Model 293 Vibroground with 7105 Test Kit or equivalent

b. 100-foot Measuring Tape, Power Kraft Z84A4098 or equivalent

4.0 MATERIALS REQUIRED

a. Ground stakes (IR and VR rods) and interconnecting test leads if not provided as a part of test set

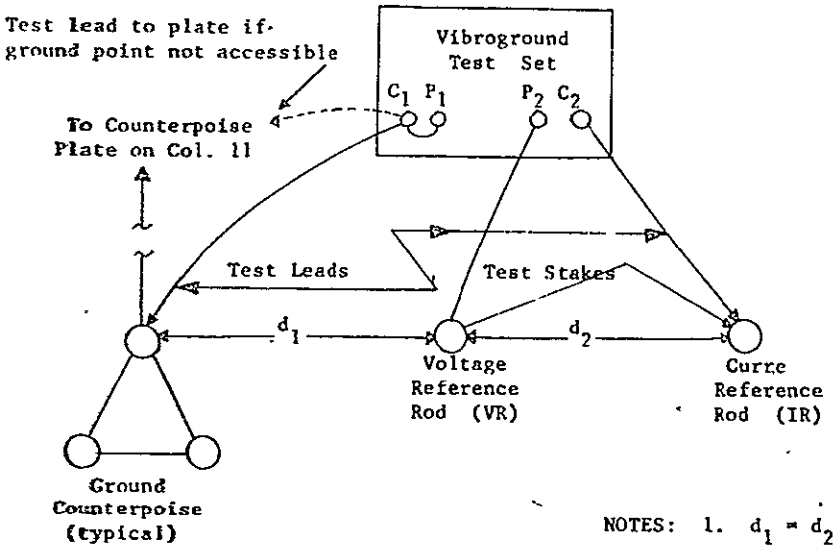
5.0 PROCEDURE

a. Allow 30 minutes for equipment warmup, if required.

b. Note measuring equipment control settings and connections to enable return to initial configuration after routine.

c. If an adequate measuring procedure is currently in use, that procedure should be used for this PMI. If a procedure is not currently in practice, the procedure given in Paragraphs 5d through 5h will serve as a guide for this purpose.

d. If the ground counterpoise, as shown in Drawing No. 77K04436(1), Sheets 6 and 8, is directly accessible or accessible through a test point provided for the purpose of measurement, connect the test equipment as is shown in Figure 13 and perform the measurement.



NOTES: 1. $d_1 = d_2 \pm 10\%$. 100-foot typical.
2. VR rod should be on-line between ground point and IR rod.
3. Reference rods should be in an area relatively free of underground conducting materials.

Figure 13 Typical Test Equipment Configuration for Earth Ground Point Resistance Measurement - MSOB

e. If the condition in step d does not hold, the connection to the EGP must be made at a location convenient for measurement. Location of the IR and VR rods must then be aligned in a straight line with a uniform spacing between rods, preferably 100 feet or greater.

f. The procedure for resistance measurement is as follows:

(1) Configure test equipment for measurement.

(2) Operate the test set to obtain an EGP resistance reading.

(3) Reset controls of test set to zero, then repeat step f(2).

(4) Repeat step f(3).

(1) Refer to KSC (NASA) Drawing No. 77K04436, 25 April 1969, Sheet 6, O & C Building (tunnel, 12-foot level).

(5) The average of the three readings can be accepted as the EGP resistance. If the readings vary over a wide range, check the test configuration for anomalies.

(6) The resistance value obtained in f(5) should be one ohm or less. Refer to KSC-STD-E-0012, Paragraph 3.5.4.2-1, 29 December 1969.

g. Upon completion of the I-Ground resistance measurement, follow the same general procedure for measurement of the Building Ground resistance.

h. Return operating equipment controls and connections to initial configuration.

.0 REPORT

a. Complete a PMI Completion Report.

b. The results of the measurements will be entered in a chronological record in the cognizant engineering office. The entry to the record will include:

- Date of test
- Equipment used
- Results of measurement
- Inspector's general comments
- Copy of report to cognizant engineer

c. The inspector will submit to the cognizant engineer a report of the PMI action. The report will include:

- A copy of the Completion Report
- Equipment used
- Results of measurement
- Discrepancies
- Inspector's general comments

.0 OBJECTIVES

a. The objective of this inspection is to establish a chronological record of the earth ground point resistance for the MSOB. When a significant departure from the record is noted, an investigation should be initiated to determine the cause.

b. The earth ground point resistance measurements given in Volume II, Section 3 of this report and past experience at KSC will serve as first entries into the record.

PREVENTIVE MAINTENANCE INSTRUCTION

EARTH GROUND POINT RESISTANCE MEASUREMENT

LC-39 PADS A AND B

ROUTINE NO. EGP-4

1.0 GENERAL INFORMATION

a. Purpose of Routine: To measure the resistance to earth of the Earth Ground Wire for Launch Pads A and B

b. Period of Performance: Semiannual

c. The time required for the performance of this routine is approximately 4 manhours.

2.0 TECHNICAL DATA REFERENCES

a. KSC-STD-E-0012, Bonding and Grounding Standard

b. National Electric Code, 1968

3.0 TEST EQUIPMENT REQUIRED

a. Ground Resistance Test Set, Associated Research Model 293 Vibroground with 7105 Test Kit, or equivalent

b. 100-Foot Measuring Tape, Power Kraft A84A4098 or equivalent.

4.0 MATERIALS REQUIRED

a. Ground stakes (VR and IR rods) and interconnecting test leads if not provided as a part of the test set

5.0 PROCEDURE

a. Allow 30 minutes for equipment warmup if required.

b. Note measuring equipment control settings to enable return to initial configuration after routine.

c. In the event that an adequate measuring procedure is currently in use, that procedure should be used for this PMI. If a procedure is not currently in practice, the procedure given in Paragraphs 5d through 5e will serve as a guide for this purpose.

d. The procedure for resistance measurement is as follows:

(1) Configure test equipment as shown in Figure 14.

(2) Operate test set to obtain an EGP resistance reading.

(3) Reset controls of test set to zero, then repeat step f(2).

(4) Repeat step f(3).

(5) Average of the three readings will be accepted as the EGP resistance. If the readings vary over a wide range, check the test configuration for anomalies.

(6) The resistance value obtained in f(5) should be one ohm or less (KSC-STD-E-0012, Paragraph 3.5.3.4.2.1, 29 December 1969).

e. Return operating equipment controls and connections to initial configuration.

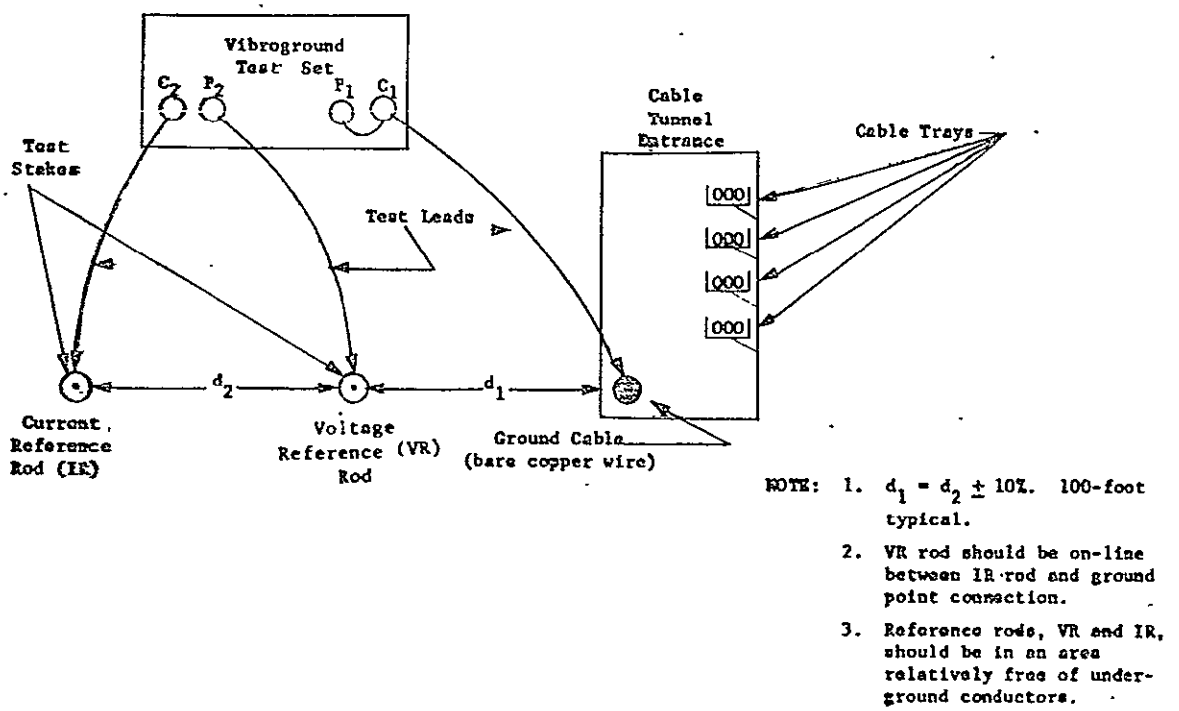


Figure 14 Typical Test Equipment Configuration for Earth Ground Resistance Measurement Pad A and Pad B

6.0 REPORT

a. Complete a PMI Completion Report.

b. The results of the measurement will be entered in a chronological record in the cognizant engineering office. The entry to the record will include:

- Date of test
- Equipment used
- Inspector's general comments
- Copy of report to cognizant engineer

c. The inspector will submit to the cognizant engineer a report of the PMI action. The report will include:

- A copy of the Completion Report
- Equipment used
- Results of measurement
- Discrepancies
- Inspector's general comments

7.0 OBJECTIVES

a. The objective of this inspection is to establish a chronological record of the earth ground point resistance for Pads A and B. When a significant departure from the record is noted, an investigation should be initiated to determine the cause.

b. The earth ground point resistance measurements given in Volume II, Section 3 of this report and past experience at KSC will serve as first entries into the record.

PREVENTIVE MAINTENANCE INSTRUCTION

INSPECTION OF BONDING

BPR-1

1.0 GENERAL INFORMATION

a. Purpose of Routine: To establish a routine inspection schedule of bonding practice. The number of facilities that should be inspected will depend upon the judgment of the cognizant engineer.

b. Inspection interval: This PMI should coincide with the Lightning Protection System PMI.

c. The time required for the performance of this routine is approximately 4 manhours per facility inspected.

2.0 TECHNICAL DATA REFERENCES

a. KSC-STD-E-0012, Bonding and Grounding Standard

b. National Electrical Code, 1968 (NPEA No. 70, 1968)

3.0 TEST EQUIPMENT REQUIRED

a. Leeds and Northrup Kelvin Bridge complete with test leads and batteries

b. Camera, Polaroid 110 or equivalent, and flash gun

4.0 MATERIALS REQUIRED

a. Film and flash gun for camera, 16 exposures or as required

b. Copy of KSC-STD-E-0012

c. List of area(s) to be inspected

5.0 PROCEDURE

a. Allow 30 minutes for equipment warmup where required.

b. Note measuring equipment control settings and connections to enable return to initial configuration after routine.

c. Within each facility inspected (i.e., Room 3227, CURFCOE in MSOB), a thorough inspection of all accessible bonds will be made. Each bond inspected will be examined for:

(1) Type of bond. Refer to Paragraph 3.2.5.1 of Reference 2a.[1]

(2) Apparent cleanliness of mating surfaces. Refer to Paragraph 3.5.2.3 of Reference 2a.

(3) Dissimilar metals in surfaces bonded together. Refer to Paragraph 3.5.2.4 of Reference 2a.

(4) Surfaces bonded by clamping or riveting. Refer to Paragraph 3.5.2.5 and 3.2.5.10 of Reference 2a.

(5) Type of bonding straps and jumpers used. Refer to Paragraph 3.5.2.6 of Reference 2a.

(6) Bonding of hinged or swivel joints. Refer to Paragraph 3.5.2.7 of Reference 2a.

(7) Bond in external locations must be corrosion resistance to the degree listed in Paragraph 3.5.2.8 of Reference 2a.

(8) Bonding of cable trays. Refer to Paragraph 3.5.2.13 of Reference 2a.

(9) Bonding of heating, ventilating, and air conditioning systems. Refer to Paragraph 3.5.2.14 of Reference 2a.

(10) Bonding of inspection covers. Refer to Paragraph 3.5.2.15 of Reference 2a.

(11) Bonding of pipes, general service. Refer to Paragraphs 3.5.2.16, 3.5.2.18, and 3.5.2.19 of Reference 2a.

(12) Bonding of pipes, exotic service. Refer to Paragraph 3.5.2.17 of Reference 2a.

(13) Bonding, miscellaneous. Refer to Paragraphs 3.5.2.20, 3.5.2.21, 3.5.2.22, and 3.5.2.23 of Reference 2a.

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[1] All references are in KSC-STD-E-0012, John F. Kennedy Space Center, NASA, Standard for Bonding and Grounding, 29 December 1969

d. A resistance measurement will be made for at least one of each of the following types of bonds:

(1) Brazed, welded, or soldered

(2) Clamped

(3) Bonding jumper

The measured resistance shall not be greater than the value listed in Paragraph 3.5.2.2 of Reference 2a. Resistance values that are higher will be reported as a discrepancy.

e. Bonding practices that are not in accordance with the standards given in KSC-STD-E-0012 will be reported as discrepancies. Photographs of discrepancies may be included in the report of inspection.

0 REPORT

a. Complete a PMI Completion Report.

b. The results of the inspection will be entered in a chronological record in the cognizant engineering office. The entry to the record will include:

- Facility inspection
- Date of inspection
- Equipment used
- Results of measurement
- Results of inspection
- Inspector's general comments
- Copy of report to cognizant engineer

c. The inspector will submit to the cognizant engineer a report of the PMI action. The report will include:

- A copy of Completion Report
- Results of inspection and measurements
- Discrepancies
- Inspector's general comments

PMI COMPLETION REPORT

1. Routine # _____

2. Date of Inspection: _____ Due: _____

3. Inspector(s): _____

_____

4. Inspection Completed: YES _____ NO _____

a. Reason for not completing: _____

_____

b. Inspection rescheduled: YES _____ NO _____ DATE: _____

c. If not rescheduled, give reason: _____

_____

5. Paragraph 5 Discrepancies: YES _____ NO _____

a. Holdover discrepancies from last report: YES _____ NO _____

b. Discrepancy Report submitted: YES _____ NO _____

c. Test Report submitted: YES _____ NO _____

(1) Addressee: _____

_____

_____

6. Attach Copy of Discrepancy Report: Initials _____

7. Attach Copy of Test Report: Initials _____

8. If Reports are Not Submitted, Give Reason: _____

_____

WITNESSED: _____

DATE: _____

SECTION 3

RECOMMENDATION

It is recommended that a comprehensive PMI program be initiated for facilities and functions that are involved in the assembly, checkout, and launch of space vehicles. The routines listed in Table 2-1 should be put into action as soon as is practicable. Additional routines should be originated until a comprehensive program has been established.

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